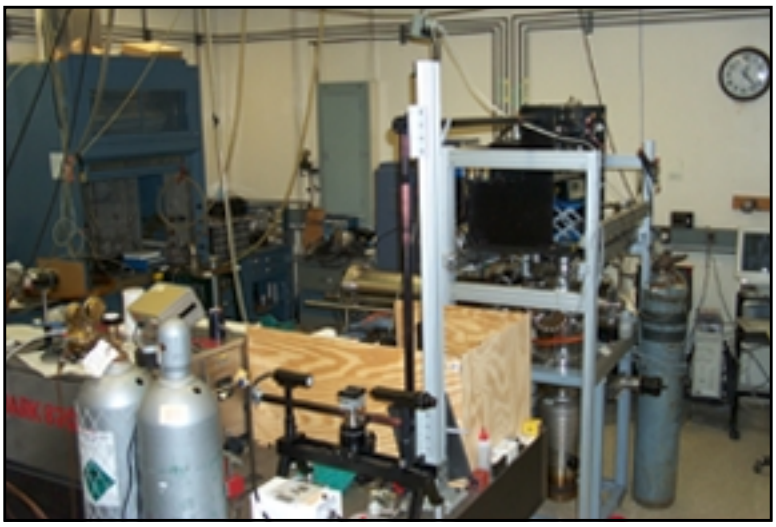
Chemical Analysis Facility



Chemical Analysis Facility

FUNCTION: Uses state-of-the-art instrumentation for trace qualitative and quantitative analysis of organic and inorganic compounds, and biomolecules from gas, liquid, and solid samples. Principal functions of the facility include analyzing samples of environmental importance, ranging from the atmospheres of submarines to polycyclic aromatic hydrocarbons in harbor sediments, and characterizing synthetic products and materials (such as polymers) produced by novel methods such as plasma deposition.

INSTRUMENTATION: Gas chromatographs with flame ionization, thermal conductivity, and electron capture detectors; liquid chromatographs with UV-visible, fluorescence, and mass spectrometer detectors; capillary electrophoresis instruments with UV-visible and conductivity detectors; a thermal desorption/gas chromatograph/mass spectrometer; a gas chromatograph/ion trap tandem mass spectrometer; a membrane introduction/ion trap tandem mass spectrometer; electrospray triple quadrupole and electrospray ion trap tandem mass spectrometers; a matrix-assisted laser desorption time-of-flight mass spectrometer; an imaging two-step laser desorption laser ionization time-of-flight mass spectrometer; graphite furnace atomic absorption and ICP emission spectrometers; and infrared, UV-visible, and NMR spectrometers.

DESCRIPTION: The facility includes instrumentation for the characterization of samples of many types using a variety of analytical techniques. Environmental samples (air, water, and sediment) are prepared by techniques such as solid-phase micro-extraction, solid-phase extraction, membrane introduction, liquid extraction, and thermal desorption. Quantitative and qualitative analytical information is provided by gas chromatography, gas chromatography/mass spectrometry, liquid chromatography, liquid chromatography/mass spectrometry, capillary electrophoresis, infrared spectrometry, UV-visible spectrophotometry, atomic absorption spectrometry, and atomic emission spectrometry. More detailed information about molecular structures can be obtained by NMR spectrometry, isotope ratio mass spectrometry, matrix-assisted laser desorption mass spectrometry and electrospray tandem mass spectrometry. The capability to characterize the spatial location of molecules on surfaces, while maintaining molecular weight information, has been added in a new imaging laser desorption/laser ionization mass spectrometer. Synthetic samples are handled in a similar fashion using many of the same techniques.

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Corrosion Engineering and Coatings Characterization Facilities

Corrosion Engineering and Coatings Characterization Facilities

FUNCTION: Performs materials corrosion engineering and prevention studies, cathodic protection design, marine coatings characterization, electrochemical systems, seawater sensor systems, and materials failure analysis related to marine environments. Additionally, laboratories support efforts at the NRL Center for Corrosion Science and Engineering located in Key West, Florida.

EQUIPMENT: Electrochemical testing equipment for ac and dc measurements; Kelvin probe; Fourier transform infrared spectroscopy; gas chromatography/mass spectroscopy; Zeta potential measurement system; PRT member on beam line X11 at the National Synchrotron Light Source; fuel cell test station; X-ray photoelectron spectroscopy; and X-ray fluorescence

DESCRIPTION: Specialized analytical laboratories determine the mechanisms of materials degradation and develop coatings technology for Naval systems. Seawater effects on materials are studied to understand fundamental physical properties of the electrochemical reactions, mechanisms of materials degradations, and the methodology for materials preservation and protection. The facilities include basic electrochemical test laboratories, surface chemical analysis, organic coatings properties measurement, mechanical failure analysis, stress corrosion cracking/hydrogen effects instrumentation, analytical analysis, and corrosion properties measurement. Marine coatings laboratories enable the analysis of barrier coating properties, surface preparation scenarios, application, and performance testing. Electrochemical facilities enable the theoretical understanding of interfacial processes and surface chemistry and use the information gained to guide materials development, improve material performance, and reduce maintenance costs.

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Marine Corrosion Facility

Marine Corrosion Facility

FUNCTION: Conducts RDT&E in direct support of current and 21st century Fleet requirements concerning seawater materials performance, corrosion behavior, and marine coatings technology.

CAPABILITIES: Cathodic Protection/Signature Analysis Physical Scale Modeling Facility; coatings testing and application facilities; controlled Atmosphere Coatings Application Chamber; weatherometer and Environmental Effects Laboratory; Heat Exchanger Test Facility; Corrosion, Metallography, and Electrochemistry Laboratory; seawater flow loop and low-velocity exposure troughs; 5-30-kt seawater flow channel; 55,000 and 110,000 gallon modeling tanks; 0-1000 psi pressurized seawater flow loop; 800-ft instrumented sacrificial anode test pier; UV and salt spray environmental test chambers; atmospheric exposure test racks; cantilever beam SCC/hydrogen effects testing; and two remotely operated vehicles.

DESCRIPTION: The Marine Corrosion Facility is located on the Naval Air Station, Trumbo Point Annex, adjacent to Key West, FL. The laboratory has an unparalleled database for natural seawater exposure testing and marine-related materials evaluation. It receives a plentiful, unpolluted supply of natural undisturbed Gulf of Mexico seawater throughout the year. The tropical climate is ideally suited for marine exposure testing and provides minimal climatic variation, with a stable biomass throughout the year. The laboratory has more than 1000 ft of waterfront access, natural "blue" ocean-quality seawater access, a 2500-ft^2 atmospheric test site, and more than 14,000 ft^2 of laboratory facilities.

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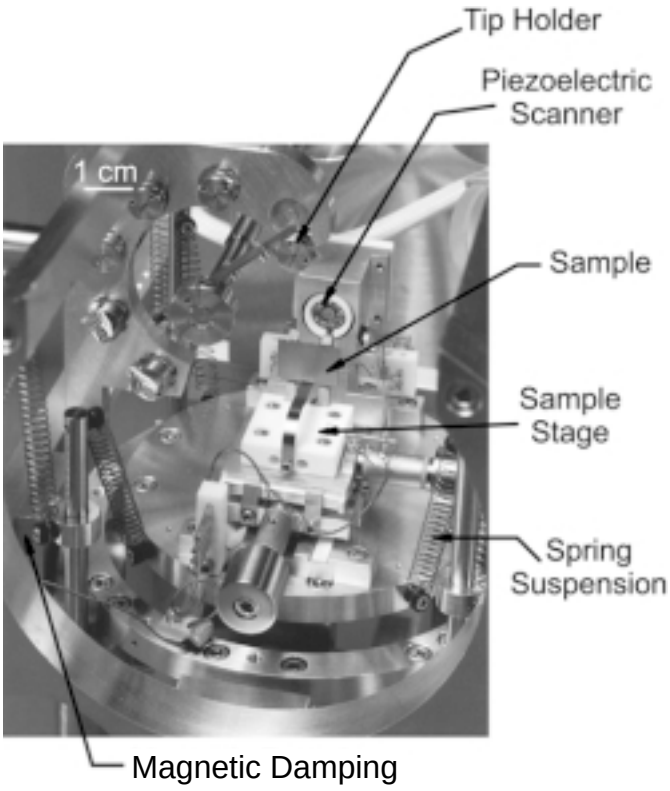
Nanometer Characterization/Fabrication Facility

Close up view of a scanning tunneling microscope (STM) used for the study of semiconductor surfaces and interfaces



FUNCTION: Characterizes the nanometer scale of biological, chemical, physical, electronic, and mechanical properties of surfaces and thin films using scanning probe microscopies/spectroscopies, and a variety of complementary surface analysis techniques. The limits of materials miniaturization are explored by using the new microscopes to fabricate and manipulate surface structures of nanometer size. This technology is used to investigate new chemical, biological, and magnetic sensors, electronic devices, and nanoscale materials.

INSTRUMENTATION: NRL-built ultra-high-vacuum (UHV) STM/S facilities; Park Scientific Instruments AutoProbe UHV STM/AFM integrated with the NRL Molecular Beam Epitaxy (MBE) Epicenter; Nanoscope IIIa multimode AFM; Digital Instruments Bioscope AFM integrated with a Zeiss Axiovert 100 inverted optical microscopy; and Micromeritics ASAP 2010 Accelerated Surface Area and Porosimetry System and Chemisorption Analyzer.

DESCRIPTION: Scanning tunneling microscopy/spectroscopy (STM/S) enables observation of the surface topography, chemical reactivity, and electronic structure of conductive substrates with atomic-scale resolution. The atomic force microscope (AFM) provides nanometer-scale resolution of surface topography, mechanical properties, and tip-surface interaction forces on both conductive and insulating substrates. The tip-surface interaction forces, including frictional forces, can be measured with nanonewton (single chemical bond) precision. A new ultra-high vacuum system for nanomanipulation and nanoprobe characterization is also planned.

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Synchrotron Radiation Facility

Instrumentation and chamber on the NRL X24C beamline at the National Synchrotron Light Source, Brookhaven National Laboratory

FUNCTION: Studies the effects of ultraviolet and X rays on solids and calibrate X-ray optics, detectors, and instruments.

DESCRIPTION: Research focuses on applying X rays to chemical and structural analysis of electronic and optical materials. Structural dynamics are monitored by diffraction carried out at the National Synchrotron Light Source (NSLS) or at major laser plasma X-ray sources, over time scales from picoseconds to hours. Synchrotron and pump-probe laser techniques elucidate the electronic structure of the ground state, transiently excited states, and photo-transformed states in insulators, semiconductors, and molecular films.

INSTRUMENTATION:

- Beamline X23B provides intense, focused X-ray fluences from 3 to 11 keV with an energy resolution of 3 $\times$ 10^{-4}. Experimental equipment includes a four-circle Huber diffractometer and apparatus for transmission, fluorescence, and electron EXAFS.
- Beamline X24C provides intense, focused ultraviolet and X-ray fluences from 1 to 1800 eV with an energy resolution of 1 $\times$ 10^{-3} (delta E/E). There are three large ultra-high vacuum experimental chambers; a photoemission chamber, a reflectometer, and a space science and plasma diagnostic instrument calibration facility.
- Beamlines X11A and X11B provide intense focused and unfocused x-ray fluence from 2 to 35 keV with an energy resolution of 2 x 10^{-4}. Experimental equipment includes apparatus for transmission and fluorescence EXAFS.
- Beamline U4B provides intense focused ultraviolet and fluence from 80 to 1200 keV with an energy resolution from 10^{-3} to 10^{-4}. Equipment includes UHV photoemission and reflectance experimental chambers.

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Ex-USS Shadwell *Advanced Fire Research Ship*

Ex-USS *Shadwell*

FUNCTION: Conducts full-scale fire/damage control experiments in a shipboard environment. This test platform can provide an integrated picture of the interactions of man, equipment, materials, tactics, doctrine, and systems in the development of fire protection/damage control concepts and technology, including the use of chemical simulants.

INSTRUMENTATION: The facility has extensive sensor and analytical sampling capabilities for measuring temperature, pressure, smoke obscuration, fluid flow, radiation flux, and total heat flux. There are video recorders for documentation of the fire tests and significant computing facilities for data collection, manipulation, and presentation. There is a 1-gigabit blown fiber network, which is tied into the data system, with 12 node rooms for input, output, and control of ship sensors and functions. This provides video coverage throughout the ship.

DESCRIPTION: Ex-USS *Shadwell* (LSD15) has an overall length of 457 ft, beam of 72 ft, and full load displacement of 9000 tons. As a test bed, the ship contains one pressure zone to study smoke management, including a collective protection system (CPS) that has been created on all levels forward of frame 35. Selected ship systems that are important to fire protection and damage control, such as ventilation, electrical power, fluid distribution, fire mains, fire pumps, and internal communications, have been reactivated. The ship has undergone major automation upgrades to its damage control systems. There is a high-pressure fine water mist system over all decks forward of frame 35.

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Fire Research Enclosure

Submarine Fire Research Facility (FIRE I)

FUNCTION: Simulates submarine fires, enclosed aircraft fires, and fires in enclosures at shore facilities.

INSTRUMENTATION: The facility has over 200 sensors measuring pressure, temperature, radiation, total heat flux, and fire byproducts. The data are collected, analyzed, and displayed in real time. Nitrogen-suppression pipes are embedded along the chamber walls. Thermocouples in the skin of the chamber record the effect of heat transfer to the chamber wall. The size and complexity of FIRE I require intricate safety considerations with built-in interlock systems. There are several television cameras to visually record the test fires.

DESCRIPTION: FIRE I is a pressurizable, 324-m^3 (11,400 ft^3) fire test facility that simulates a one-quarter scale submarine compartment capable of pressurization to more than 6 atmospheres. This facility is used to study large-scale confined fires under controlled conditions and test prototype equipment and firefighting agents. Two fixed fire suppression systems for enclosures—nitrogen pressurization and preliminary water mist—have been tested.

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Fire Research Test Bed

Large-Scale Fire Research Test Bed Facility

FUNCTION: Performs real-scale fire suppression experiments that simulate actual Navy platform conditions.

INSTRUMENTATION: Specific instrumentation is incorporated as a function of the particular experiment and includes sensors, gas sampling, droplet size measurements, control equipment, video recording, and fluid flow measurements.

DESCRIPTION: The test bed has two test compartments that have been used to simulate different shipboard compartments. These compartments are used to study large-scale confined fires under controlled conditions and test prototype fire suppression agents and equipment. Suppressants evaluated to date include gaseous agents, water mist, solid aerosols, and hybrids gas/powder agents.

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Large-Scale Damage Control Facility

Large-Scale Damage Control Facility

FUNCTION: Performs large-scale fire protection experiments that simulate actual Navy platform conditions. Remote control firefighting systems are also tested.

INSTRUMENTATION: Specific instruments for these test beds are incorporated as a function of the particular experiment, but include sensors, gas sampling, control equipment, mixing vessels, calibrated fuel and aqueous flow metering, and video recording. The fire test building has a large cone calorimeter for full-scale fire tests of materials and furnishings.

DESCRIPTION: The facility consists of five buildings and three test beds. Two of the buildings are for enclosed fire experiments, qualification of firefighting agents, efficacy of dispensing these agents, and control and visibility through smoke. A third building is a staging area and a fourth is for storage. The fifth building contains a hydraulics laboratory and is equipped with a full-scale shipboard balanced pressure proportioner for aqueous film forming foam. A test bed simulates the lower section of a submarine for studying bilge fires and their extinguishment. A simulated 930 m^3 (10,000 ft^2) flight test bed is used to develop fire scenarios and suppression technologies. The third test bed has two test compartments, with internal volumes of 28 and 300 m^3 (1,000 and 10,500 ft^3), which are used for fire suppression experiments.

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